

CLAIMS

WHAT IS CLAIMED:

1. A method comprising:

forming a gate dielectric above a surface of the substrate;

forming a doped-poly gate structure above the gate dielectric, the doped-poly gate structure having an edge region; and

forming a dopant-depleted-poly region in the edge region of the doped-poly gate structure adjacent the gate dielectric.

2. The method of claim 1, wherein forming the dopant-depleted-poly region includes implanting a counter-dopant into the edge region of the doped-poly gate structure adjacent the gate dielectric.

3. The method of claim 2, the method further comprising:

implanting the counter-dopant at an angle  $\alpha$  with respect to a direction perpendicular to the surface, wherein the angle  $\alpha$  is in a range of about  $7^{\circ}$ - $45^{\circ}$ ;

rotating the substrate through at least one of approximately  $90^{\circ}$  (approximately  $\pi/2$  radians), approximately  $180^{\circ}$  (approximately  $\pi$  radians), and approximately  $270^{\circ}$  (approximately  $3\pi/2$  radians); and

implanting the counter-dopant at the angle  $\alpha$  with respect to the direction perpendicular to the surface.

4. The method of claim 1, the method further comprising:

forming a photoresist mask defining a source/drain extension (SDE) adjacent the doped-poly gate structure.

5. The method of claim 2, the method further comprising:

5 forming a photoresist mask defining a source/drain extension (SDE) adjacent the doped-poly gate structure.

6. The method of claim 3, the method further comprising:

10 forming a photoresist mask defining a source/drain extension (SDE) adjacent the doped-poly gate structure.

7. The method of claim 1, wherein forming the dopant-depleted-poly region includes depleting the edge region of the doped-poly gate structure adjacent the gate dielectric by forming depleting dielectric spacers adjacent the doped-poly gate structure.

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8. The method of claim 2, wherein implanting the counter-dopant into the edge region of the doped-poly gate structure includes implanting one of phosphorus, arsenic, boron and boron fluoride into the edge region of the doped-poly gate structure, a dose of the one of phosphorus, arsenic, boron and boron fluoride ranging from about  $1.0 \times 10^{14}$  ions/cm<sup>2</sup> to about  $1.0 \times 10^{15}$  ions/cm<sup>2</sup> at an implant energy ranging from about 0.2-5 keV.

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9. The method of claim 3, wherein implanting the counter-dopant into the edge region of the doped-poly gate structure includes implanting one of phosphorus, arsenic, boron and boron fluoride into the edge region of the doped-poly gate structure, a dose of the one of

phosphorus, arsenic, boron and boron fluoride ranging from about  $1.0 \times 10^{14}$  ions/cm<sup>2</sup> to about  $1.0 \times 10^{15}$  ions/cm<sup>2</sup> at an implant energy ranging from about 0.2-5 keV.

10. The method of claim 1, wherein forming the dopant-depleted-poly region in the edge region of the doped-poly gate structure includes forming the dopant-depleted-poly region to have a depth from the edge of the doped-poly gate structure, the depth of the dopant-depleted-poly region ranging from about 50 Å-100 Å.

11. A method comprising:

forming a gate dielectric above a surface of the substrate;

forming a doped-poly gate structure above the gate dielectric, the doped-poly gate structure having an edge region;

forming a source/drain extension (SDE) adjacent the doped-poly gate structure; and

forming a dopant-depleted-poly region in the edge region of the doped-poly gate structure adjacent the gate dielectric and a dopant-depleted-SDE region in the substrate under the edge region of the doped-poly gate structure.

12. The method of claim 11, wherein forming the dopant-depleted-poly region includes implanting a counter-dopant into the edge region of the doped-poly gate structure adjacent the gate dielectric, and forming the dopant-depleted-SDE region includes implanting the counter-dopant into the substrate under the edge region of the doped-poly gate structure.

13. The method of claim 12, the method further comprising:

implanting the counter-dopant at an angle  $\alpha$  with respect to a direction perpendicular to the surface, wherein the angle  $\alpha$  is in a range of about  $7^\circ$ - $45^\circ$ ;

rotating the substrate through at least one of approximately  $90^\circ$  (approximately  $\pi/2$  radians), approximately  $180^\circ$  (approximately  $\pi$  radians), and approximately  $270^\circ$  (approximately  $3\pi/2$  radians); and

implanting the counter-dopant at the angle  $\alpha$  with respect to the direction perpendicular to the surface.

14. The method of claim 11, the method further comprising:  
forming a photoresist mask defining the SDE adjacent the doped-poly gate structure.

15. The method of claim 12, the method further comprising:  
forming a photoresist mask defining the SDE adjacent the doped-poly gate structure.

16. The method of claim 13, the method further comprising:  
forming a photoresist mask defining the SDE adjacent the doped-poly gate structure.

17. The method of claim 11, wherein forming the dopant-depleted-poly region includes depleting the edge region of the doped-poly gate structure adjacent the gate dielectric by forming depleting dielectric spacers adjacent the doped-poly gate structure, and forming the dopant-depleted-SDE region includes depleting the SDE in the substrate under

the edge region of the doped-poly gate structure by forming the depleting dielectric spacers above the SDE.

18. The method of claim 12, wherein implanting the counter-dopant into the edge  
5 region of the doped-poly gate structure includes implanting one of phosphorus, arsenic, boron and boron fluoride into the edge region of the doped-poly gate structure, and implanting the counter-dopant into the substrate under the edge region of the doped-poly gate structure includes implanting the one of phosphorus, arsenic, boron and boron fluoride into the substrate under the edge region of the doped-poly gate structure, a dose of the one of  
10 phosphorus, arsenic, boron and boron fluoride ranging from about  $1.0 \times 10^{14}$  ions/cm<sup>2</sup> to about  $1.0 \times 10^{15}$  ions/cm<sup>2</sup> at an implant energy ranging from about 0.2-5 keV.

19. The method of claim 13, wherein implanting the counter-dopant into the edge  
15 region of the doped-poly gate structure includes implanting one of phosphorus, arsenic, boron and boron fluoride into the edge region of the doped-poly gate structure, and implanting the counter-dopant into the substrate under the edge region of the doped-poly gate structure includes implanting the one of phosphorus, arsenic, boron and boron fluoride into the substrate under the edge region of the doped-poly gate structure, a dose of the one of phosphorus, arsenic, boron and boron fluoride ranging from about  $1.0 \times 10^{14}$  ions/cm<sup>2</sup> to  
20 about  $1.0 \times 10^{15}$  ions/cm<sup>2</sup> at an implant energy ranging from about 0.2-5 keV.

20. The method of claim 11, wherein forming the dopant-depleted-poly region in the edge region of the doped-poly gate structure includes forming the dopant-depleted-poly region to have a first depth from the edge of the doped-poly gate structure, the first depth  
25 ranging from about 50 Å-100 Å, and forming the dopant-depleted-SDE region in the

substrate under the edge region of the doped-poly gate structure includes forming the dopant-depleted-SDE region to have a second depth from the surface of the substrate, the second depth ranging from about 50 Å-100 Å.

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forming a gate dielectric above a surface of the substrate;

forming a doped-poly gate structure above the gate dielectric, the doped-poly gate structure having an edge region; and

10           forming a dopant-depleted-poly region in the edge region of the doped-poly gate structure adjacent the gate dielectric.

15           22.    The MOS transistor of claim 21, wherein forming the dopant-depleted-poly region includes implanting a counter-dopant into the edge region of the doped-poly gate structure adjacent the gate dielectric.

23.    The MOS transistor of claim 22, the method further comprising:

20           implanting the counter-dopant at an angle  $\alpha$  with respect to a direction perpendicular to the surface, wherein the angle  $\alpha$  is in a range of about 7°-45°;

rotating the substrate through at least one of approximately 90° (approximately  $\pi/2$  radians), approximately 180° (approximately  $\pi$  radians), and approximately 270° (approximately  $3\pi/2$  radians); and

25           implanting the counter-dopant at the angle  $\alpha$  with respect to the direction perpendicular to the surface.

24. The MOS transistor of claim 21, the method further comprising:  
forming a photoresist mask defining a source/drain extension (SDE) adjacent  
the doped-poly gate structure.

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25. The MOS transistor of claim 22, the method further comprising:  
forming a photoresist mask defining a source/drain extension (SDE) adjacent  
the doped-poly gate structure.

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26. The MOS transistor of claim 23, the method further comprising:  
forming a photoresist mask defining a source/drain extension (SDE) adjacent  
the doped-poly gate structure.

27. The MOS transistor of claim 21, wherein forming the dopant-depleted-poly  
region includes depleting the edge region of the doped-poly gate structure adjacent the gate  
dielectric by forming depleting dielectric spacers adjacent the doped-poly gate structure.

28. The MOS transistor of claim 22, wherein implanting the counter-dopant into  
the edge region of the doped-poly gate structure includes implanting one of phosphorus,  
arsenic, boron and boron fluoride into the edge region of the doped-poly gate structure, a  
dose of the one of phosphorus, arsenic, boron and boron fluoride ranging from  
about  $1.0 \times 10^{14}$  ions/cm<sup>2</sup> to about  $1.0 \times 10^{15}$  ions/cm<sup>2</sup> at an implant energy ranging from  
about 0.2-5 keV.

29. The MOS transistor of claim 23, wherein implanting the counter-dopant into the edge region of the doped-poly gate structure includes implanting one of phosphorus, arsenic, boron and boron fluoride into the edge region of the doped-poly gate structure, a dose of the one of phosphorus, arsenic, boron and boron fluoride ranging from about  $1.0 \times 10^{14}$  ions/cm<sup>2</sup> to about  $1.0 \times 10^{15}$  ions/cm<sup>2</sup> at an implant energy ranging from about 0.2-5 keV.

30. The MOS transistor of claim 21, wherein forming the dopant-depleted-poly region in the edge region of the doped-poly gate structure includes forming the dopant-depleted-poly region to have a depth from an edge of the doped-poly gate structure, the depth of the dopant-depleted-poly region ranging from about 50 Å-100 Å.

31. An MOS transistor having a reduced Miller capacitance, the MOS transistor formed by a method comprising:

forming a gate dielectric above a surface of the substrate;

forming a doped-poly gate structure above the gate dielectric, the doped-poly gate structure having an edge region;

forming a source/drain extension (SDE) adjacent the doped-poly gate structure; and

forming a dopant-depleted-poly region in the edge region of the doped-poly gate structure adjacent the gate dielectric and a dopant-depleted-SDE region in the substrate under the edge region of the doped-poly gate structure.



32. The MOS transistor of claim 31, wherein forming the dopant-depleted-poly region includes implanting a counter-dopant into the edge region of the doped-poly gate structure adjacent the gate dielectric, and forming the dopant-depleted-SDE region includes implanting the counter-dopant into the substrate under the edge region of the doped-poly gate structure, reducing the Miller capacitance of the edge region of the doped-poly gate structure of the MOS transistor.

33. The MOS transistor of claim 32, the method further comprising:  
implanting the counter-dopant at an angle  $\alpha$  with respect to a direction perpendicular to the surface, wherein the angle  $\alpha$  is in a range of about 7°-45°;  
rotating the substrate through at least one of approximately 90° (approximately  $\pi/2$  radians), approximately 180° (approximately  $\pi$  radians), and approximately 270° (approximately  $3\pi/2$  radians); and  
implanting the counter-dopant at the angle  $\alpha$  with respect to the direction perpendicular to the surface.

34. The MOS transistor of claim 31, the method further comprising:  
forming a photoresist mask defining the SDE adjacent the doped-poly gate structure.

35. The MOS transistor of claim 32, the method further comprising:  
forming a photoresist mask defining the SDE adjacent the doped-poly gate structure.

36. The MOS transistor of claim 33, the method further comprising:  
forming a photoresist mask defining the SDE adjacent the doped-poly gate  
structure.

5 37. The MOS transistor of claim 31, wherein forming the dopant-depleted-poly  
region includes depleting the edge region of the doped-poly gate structure adjacent the gate  
dielectric by forming depleting dielectric spacers adjacent the doped-poly gate structure, and  
forming the dopant-depleted-SDE region includes depleting the SDE in the substrate under  
the edge region of the doped-poly gate structure by forming the depleting dielectric spacers  
10 above the SDE.

38. The MOS transistor of claim 32, wherein implanting the counter-dopant into  
the edge region of the doped-poly gate structure includes implanting one of phosphorus,  
arsenic, boron and boron fluoride into the edge region of the doped-poly gate structure, and  
15 implanting the counter-dopant into the substrate under the edge region of the doped-poly gate  
structure includes implanting the one of phosphorus, arsenic, boron and boron fluoride into  
the substrate under the edge region of the doped-poly gate structure, a dose of the one of  
phosphorus, arsenic, boron and boron fluoride ranging from about  $1.0 \times 10^{14}$  ions/cm<sup>2</sup> to  
about  $1.0 \times 10^{15}$  ions/cm<sup>2</sup> at an implant energy ranging from about 0.2-5 keV.

20 39. The MOS transistor of claim 33, wherein implanting the counter-dopant into  
the edge region of the doped-poly gate structure includes implanting one of phosphorus,  
arsenic, boron and boron fluoride into the edge region of the doped-poly gate structure, and  
implanting the counter-dopant into the substrate under the edge region of the doped-poly gate  
25 structure includes implanting the one of phosphorus, arsenic, boron and boron fluoride into

the substrate under the edge region of the doped-poly gate structure, a dose of the one of phosphorus, arsenic, boron and boron fluoride ranging from about  $1.0 \times 10^{14}$  ions/cm<sup>2</sup> to about  $1.0 \times 10^{15}$  ions/cm<sup>2</sup> at an implant energy ranging from about 0.2-5 keV.

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10            41.    An MOS transistor comprising:  
a gate dielectric above a surface of a substrate;  
15            a doped-poly gate structure above the gate dielectric, the doped-poly gate structure having an edge and an edge region; and  
a dopant-depleted-poly region in the edge region of the doped-poly gate structure adjacent the gate dielectric.

20            42.    The MOS transistor of claim 41, wherein the dopant-depleted-poly region has a depth from the edge of the doped-poly gate structure, the depth of the dopant-depleted-poly region ranging from about 50 Å-100 Å.

43. The MOS transistor of claim 41, wherein the MOS transistor has a reduced Miller capacitance in the edge region of the doped-poly gate structure of the MOS transistor due to the dopant-depleted-poly region.

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44. An MOS transistor comprising:

a gate dielectric above a surface of a substrate;

a doped-poly gate structure above the gate dielectric, the doped-poly gate structure having an edge and an edge region;

a source/drain extension (SDE) adjacent the doped-poly gate structure;

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a dopant-depleted-poly region in the edge region of the doped-poly gate structure adjacent the gate dielectric; and

a dopant-depleted-SDE region in the substrate under the edge region of the doped-poly gate structure.

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45. The MOS transistor of claim 44, wherein the dopant-depleted-poly region has a first depth from the edge of the doped-poly gate structure, the first depth ranging from about 50 Å-100 Å, and the dopant-depleted-SDE region has a second depth from the edge of the doped-poly gate structure, the second depth ranging from about 50 Å-100 Å.

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46. The MOS transistor of claim 44, wherein the MOS transistor has a reduced Miller capacitance in the edge region of the doped-poly gate structure of the MOS transistor due to the dopant-depleted-poly region and the dopant-depleted-SDE region.